bacter cells. Judging, therefore, from the very small number of organisms which are found in the calcareous sand, Azotobacter, a nitrogen fixing organism, seems to be one of the earliest and one of the most numerous organisms. The nitrogen fixing power of the soils as measured by the ordinary laboratory test in solution cultures, in contrast with their nitrogen transforming powers, seem to be as vigorous as those of excellent soils. It is interesting, moreover, that the calcareous sand fixed about $\frac{5}{8}$ as much nitrogen in the tests mentioned as the surface soil from the wooded land and about $\frac{5}{8}$ as much as the subsoil of the same land.

Space does not permit a consideration here of some of the pure cultures of bacteria and fungi which were isolated from the soil samples studied. Three species of Actinomyces found appear to be new and as yet remain unnamed. Some of the common organisms of all soils were found, including bacteria, *Actinomyces*, and fungi. These will all be described in detail in a forthcoming paper, mention of which has already been made above.

It is a privilege to acknowledge again our obligation to Dr. A. G. Mayer for his kindness in sending the samples and for his interest in the work. We also express thanks to Dr. H. J. Conn and to Dr. S. A. Waksman for assisting in identification of a few cultures of bacteria and of *Actinomyces*, respectively.

AUTONOMOUS RESPONSES OF THE LABIAL PALPS OF ANODONTA[1]

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Although the ciliary responses of the labial palps of pelecypods have been much studied, the muscular movements of these organs have been entirely neglected. If one valve of an Anodonta is cautiously chipped off leaving the subjacent mantle-lobe intact and the animal resting in the opposite valve, the mantle-lobe thus freed may be folded back so as to expose the parts of the animal lying within the mantle chamber. In this way the labial palps in an almost undisturbed condition may be exposed and worked upon.

In such a preparation the external palp is to be seen resting on the internal one and both are quite flat. If, now, the external palp is touched with a blunt pointed instrument, particularly in its mid-dorsal region, the organ quickly buckles in on its dorsal edge close to its attachment to the mantle and soon after begins to curl from its free tip toward its attached base. On stimulating the internal palp, it responds as the external one does. Both palps in responding curl away from their opposed faces. The vigor of their response is apparently proportional to the stimulus. Grains of sand dropped on the outer face of the external palp affect it as a slight mechanical stimulus, which calls

forth some curling but almost no buckling. Currents of water when driven against the palp have very little effect as stimuli unless they are strong enough to indent the palp.

The palps are also open to chemical stimulation and the responses thus called forth are commonly much more pronounced than those due to mechanical stimulation. The chemical stimuli employed consisted in solutions of a number of common salts, acids, and alkalis, of such non-electrolytes as ethyl alcohol, sugar, urea, quinine and so forth, and of mixtures such as beef extract and the like. These were used in varying concentrations and to all, except sugar, a reaction much like that seen in vigorous mechanical stimulation was observed. In reaction to chemical stimulation, however, the palp showed a tendency to roll up tightly from the tip rather than simply to curl upon itself.

Electricity is also a stimulus for the palp. A faradic current just strong enough to be slightly stinging to the human tongue caused the palp to respond as to a mechanical stimulus. In efficiency the electrical stimulus was apparently midway between the mechanical and the chemical stimuli.

A jet of hot water that emerged from the container at 54°C. caused the palp to curl vigorously when it was directed on that organ in water at 16.5°C. A similar jet of water at the temperature of that in which the clam was, had no stimulating effect on the palp.

A beam of sunlight, or of strong electric light, or a sudden burst of light from flash-light powder had the remarkable property of causing the palp to curl. The response, which of course occurred well under water, though slower in its appearance than the responses to other forms of stimuli, followed so quickly on the stimulus that there was no doubt that the light, and not some accompanying disturbance, was the effective agency.

The surprising feature in all these responses is that they take place as effectively on a palp that has been freshly cut from a clam as on the palp intact. Careful comparative inspection of the reacting palps disclosed no obvious difference between the efficiency of these organs when normally attached to the clam and after they had been severed from it. On cutting a palp from a clam for experimental work, it is well to allow it to remain at least a quarter of an hour in quiet water before subjecting it to stimulation. Such a palp is responsive for about an hour and a half after removal. This condition shows that the palp contains within itself the neuromuscular organization necessary for all the responses described in this paper, and that it, therefore, possesses an autonomy even more complete than that of the vertebrate heart and comparable with what is shown by the tentacle of an actinian.

It is intended to continue the line of investigations suggested by these studies and to extend them to the histology of the parts concerned.

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